CALFED Bay-Delta Program Project Information Form
Watershed Program - Full Proposal Cover Sheet

Attach to the cover of full proposal. All applicants must fill out this Information Form for their proposal. Failure to answer these questions and include them with the application will result in the application being considered nonresponsive and not considered for funding.

1. Full Proposal Title: Napa River Watershed Mapping Partnership
Concept Proposal Title/Number: Use of laser altimetry to provide new high…/WSP01-0119
Applicant: San Francisco Regional Water Quality Control Board
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2. Type of Project: Indicate the primary topic for which you are applying (check only one)

__X__Assessment
_____Capacity Building
_____Education
_____Implementation
_____Monitoring
_____Outreach
_____Planning
_____Research

3. Type of Applicant:

_____Academic Institution/University
_____Federal Agency
_____Joint Venture
_____Local Government
_____Non-Profit
_____Private party
__X__State Agency
_____Tribe or Tribal Government

4. Location (including County):

What major watershed is the project primarily located in:
_____Klamath River (Coast and Cascade Ranges)
_____Sacramento River (Coast, Cascade and Sierra Ranges)
_____San Joaquin River (Coast and Sierra Ranges)
__X__Bay-Delta (Coast and Sierra Ranges)
_____Southern CA (Coast and Sierra Ranges)
_____Tulare Basin (Coast, Sierra and Tehachapi Ranges)

5. Amount of funding requested: $318,300_____
Cost share/in-kind partners? __X__Yes _____No
Identify partners and amount contributed by each:

Partners	Amount of Funding	Task Funded
Regional Board	$47,317	Staff and supplies
Regional Board	$100,000	Contractor services
Regional Board	$45,000	Sediment TMDL study
Regional Board	$10,000	SFEI 205j grant
Regional Board	$15,000	Coastal Conservancy Phase I study
University California Berkeley	$17,000	Existing Research Funds

6. Have you received funding from CALFED before? _____Yes __✓__No
   If yes, identify project title and source of funds:

By signing below, the applicant declares the following:

1. The truthfulness of all representations in their proposal
2. The individual signing this form is entitled to submit the application on behalf of the applicant (if the applicant is an entity or an organization)
3. The person submitting the application has read and understood the conflict of interest and confidentiality discussion in the Watershed Program Proposal Solicitation Package and waives any and all rights to privacy and confidentiality of the proposal on behalf of the applicant, to the extent provided in the Proposal Solicitation Package.

_____

Printed name of applicant

_____

Signature of applicant

NAPA RIVER WATERSHED MAPPING PARTNERSHIP

LIDAR Full Proposal

1. Describe your project, its underlying assumptions, expected outcomes, timetable for completion, and general methodology or process. 3 PAGES

SUMMARY

We propose to advance ongoing watershed management and restoration efforts in the Napa River basin by (1) using airborne laser altimetry to generate topographic maps and watershed data of much higher resolution than currently exists, and (2) demonstrating the application of desktop watershed models that take advantage of these higher resolution data to improve our understanding of watershed processes, conditions, and restoration opportunities and constraints in the Napa River basin. Although the Napa Basin provides many opportunities for watershed restoration, it also presents a number of challenges: a large area (426 mi^2); a wide diversity of land and water uses; many parties currently conducting various inventory, monitoring, management, restoration, and regulatory efforts; and limited access (a very large portion of the basin is in private ownership). The proposed approach may be the only way to create a spatially explicit information database of sufficient resolution to allow for rapid yet comprehensive watershed analysis and restoration planning. The project team has extensive working knowledge of the Napa Basin and demonstrated expertise in all of the various tools and technologies being proposed for this project. The project is expected to provide benefits to many stakeholders in the watershed and has generated substantial local support (see Table 1 and attached letters).

INTRODUCTION

The Napa River, in Napa County, CA, drains a 426-mi^2 watershed that is tributary to the shallows of San Pablo Bay located at the mouth of the Sacramento-San Joaquin Estuary. As with many Sacramento-San Joaquin basin tributaries, extensive landscape-scale changes in response to agriculture and urban land uses have created potential conflicts related to desired resource conditions and uses (e.g., sediment load, flood management, water supply, and aquatic habitat for native species). Historically, the Napa River watershed was a biologically diverse and productive watershed. Although the abundance and distribution of several species are thought to be substantially diminished, the watershed continues to support a diverse and almost entirely intact[1] community of 16 native fish species including steelhead, fall-run chinook salmon, Pacific and river lamprey, hardhead, hitch, tule perch, and Sacramento splittail (Leidy 1997). Such diversity is unmatched in other Central Valley streams (Leidy 2000), and perhaps makes the recovery of native species in the Napa River more easily accomplished through ongoing and future restoration efforts. Other attributes that make the Napa River a priority watershed for native fisheries recovery include: a historically large steelhead run, an existing population of endangered California freshwater shrimp, many large tributaries not intensively diverted or regulated, short migration distance for anadromous species, and well-established and effective watershed planning and stewardship groups.

The ***goal*** of this project is to create a "desktop watershed model" (similar to the approach described by Montgomery et al. 1998a), developed from high-resolution digital topographic data used in combination with surface attribute data (such as geology, vegetation, land use), and demonstrate how it can be used to model linkages between land uses and ecosystem response to help guide management decision-making in the Napa Basin. The high-resolution desktop watershed model will provide a far more accurate and complete representation of watershed topography than is currently available, allowing the entire stream channel network and important hillslope features (e.g., ridges, un-channeled hollows, alluvial fans, roads, landslide hazard areas) to be accurately located and mapped. The data will become part of a spatial geographic information system (GIS), allowing them to be readily combined with other GIS information to enable powerful synergistic physical and ecological analyses of the watershed. The desktop watershed approach will allow us to:

1) develop hypotheses about expected resource conditions (e.g., landslide locations, river bed grain size, stream temperature) that can be used to guide field work;

2) extrapolate site-specific information to entire watersheds (e.g., field measurements of key channel parameters such as bankfull width and depth from selected sites can be extrapolated to the entire network using widely tested regional hydraulic geometry relations [Leopold and Maddock 1953]); and

3) model causal linkages between land-use and resource states (e.g., linking the effects of land uses activities, such as road or housing development, to changes in the amount, timing, or spatial pattern of watershed inputs, such as water or sediment, delivered to the channel network; then linking these changes in inputs to alterations in amount and quality of physical aquatic habitat, and finally linking the response of fish populations to these changes in habitat conditions).

[1] Coho salmon is the only native fish species that has been extirpated from the basin.

To accomplish our goal of creating a desktop watershed model, we propose to collect high-resolution digital topographic data using light detection and ranging technology (LIDAR) to develop a high-resolution (5-meter grid spacing or finer) digital terrain model (DTM) covering the entire watershed. LIDAR has revolutionized the quality of digital topographic data and hence the way in which landscapes can be analyzed and managed (see Figures 1-4). In addition to providing vastly improved base maps for registering observations, it is now possible to detect or measure:

- small roads and possibly skid trails
- locally accurate channel slopes
- the extended channel network, including dimensions on larger channels
- locally accurate hillslope topography to model mass wasting processes
- landscape change over time (using repeat surveys).

We propose to generate a high resolution DTM from the LIDAR data and use it in combination with desktop watershed models and a GIS to facilitate watershed assessment and restoration planning work being done in the Napa Basin including: (1) the Regional Water Quality Control Board's sediment total maximum daily load (TMDL) study; (2) the California Coastal Conservancy's restoration planning program; (3) proposed tributary watershed assessments to be conducted by Napa County Resource Conservation District (RCD) and San Francisco Estuary Institute; (4) assessment of flood severity and risk in the Yountville area being contemplated by Napa County Flood Control District in partnership with the RCD; and (5) programs being considered by Napa County Planning Department in its management of hillside agriculture and development projects (Table 1). In addition to these direct applications in the Napa Basin, the work described in this proposal will demonstrate tools that might be applied to watersheds throughout the Bay/Delta region.

UNDERLYING ASSUMPTIONS

The primary assumption in our watershed analysis approach is that physical watershed attributes, including local topography, climate, and disturbance regime, influence the spatial distribution and abundance of native and non-native species. Understanding the linkages between the physical environment and habitat for these species depends on a satisfactory representation of those physical features important to biota. For example, fish species have specific habitat preferences that may correspond to identifiable physical features, such as channel gradient, substrate texture, or water depth. Representing the abundance of such habitat features at biologically relevant scales (especially at the reach-scale) requires a full and accurate representation of the stream channel network, and accurate local estimates of slope (both adjacent hillslope and channel gradient), channel confinement, and drainage area. Existing digital datasets, principally the 10-meter and 30-meter 7.5-minute United States Geological Survey (USGS) digital elevation models (DEM's), cannot capture the extremely fine local topographic heterogeneity, especially with regard to variability in local slope (Figure 2), that is critical for delineating channels in low-lying, floodplain areas where coarser scales of data can result in significant misrepresentations of the stream channel network (Figures 2 and 4). As a consequence, successful use of these models demands costly and labor-intensive data rectification routines as well as collecting large amounts of field data. In comparison, high-resolution LIDAR data provide fine enough resolution to capture biologically significant heterogeneity without costly additional work and thus represent a more economical and efficient means to better understanding the biophysical system of the Napa Basin as well as our ability to plan for and manage the watershed.

GENERAL METHODOLOGY

The methodology we will apply involves the acquisition of high-resolution topographic data, processing of those data to create a high-resolution ground surface DTM, and the mapping and modeling of landscape features using the DTM and other data sources. Local field data from various sources, including field surveys conducted specifically for this study, will be used for validating models and maps (see Section 5d). Additional information on potential applications is provided in Table 1.

LIDAR Data Acquisition and Processing. LIDAR is a remote-sensing technology that uses laser pulses emitted from an airborne sensor to measure the elevation of objects at or near Earth's surface (Figures 1 and 3). Data collected will include X, Y, and Z coordinates as well as intensity value for the first and last return from each pulse, where, in the case of multiple returns, the first return records vegetation height and the last return records ground elevation. Intensity value data provide information on the reflective quality of the surface and can be used to differentiate surfaces that might not otherwise be topographically distinct (e.g., the transition from a paved road to a dirt or gravel road) (Figure 3).

Mapping and Modeling of Landscape Features. LIDAR data will be used to develop a high-resolution ground surface (bare earth) DTM. The ground surface DTM will be used to produced high-resolution shaded relief and topographic contour maps. The DTM may also be used by Napa County and the US Army Corps of Engineers (USACE) to develop high-resolution digital orthophotographs of the watershed. LIDAR data will be used to map and model a more accurate stream channel network that captures the full length and spatial distribution of the channel network, including delineation of small headwater channels. Channel slope, drainage area, and confinement parameters will be measured for each reach using the

high-resolution DTM. Important channel dimensions (e.g., bankfull width and depth) and estimates of local grain size size properties and channel form (e.g., pool-riffle, plane-bed, step-pool, and cascade) will be calculated using hydraulic geometry relationships developed from local field-based surveys. Shallow landslide potential and deep-seated landslides (mass wasting) will be modeled and mapped using two desktop watershed modeling applications developed by project team members at the University of California at Berkeley (UC Berkeley). Shallow landslide potential will be predicted using SHALSTAB, a parameter-free shallow slope instability model that uses slope and drainage area to identify those parts of the landscape at risk from shallow landslide failure (Dietrich et al. 1992, 1993; Montgomery and Dietrich 1994). The Roering Index (Roering et al. 1996) will be used to detect and map evidence of deep-seated landslide failures. Furthermore, this project would explore, on a pilot basis for selected portions of the watershed, whether the spacing of high-resolution LIDAR data points will be sufficiently close to allow delineation of small roads (which create linear slope discontinuities in the DTM). If feasible, these data will be used to map the non-urban road network, including unpaved, minor, and abandoned roads. In addition to elevation data, return intensity data collected by the LIDAR sensor is capable of distinguishing differential reflectance of ground surfaces, which may allow us to detect changes in road surface composition (e.g., paved, gravel, dirt), which are not topographically expressed. By combining stream channel and road network data, we should also be able to accurately map the location of stream crossings and culverts.

SUMMARY OF EXPECTED OUTCOMES

The LIDAR DTM and GIS analyses will be used by the Regional Water Quality Control Board (Regional Board) as a building block for conducting a comprehensive watershed analysis to address potential water quality and sediment problems and to identify and prioritize stream/riparian habitat restoration programs. The State Coastal Conservancy is a partner in the watershed analysis and expects to implement several priority projects identified as a result of these analyses. Napa County Planning will use the digital elevation data and watershed analysis to further inform review and permitting of existing and future agricultural and residential developments. There are numerous other potential applications of the LIDAR and DTM data in the Napa watershed (see Table 1 and Letters of Support).

Basic LIDAR, DTM-modeling and mapping products will include:

- unprocessed LIDAR data for first and last return and intensity,
- processed LIDAR data for last return (ground surface or bare earth),
- ground surface (bare earth) DTM for the entire basin,
- contour and shaded relief maps and GIS coverages for the entire basin,
- complete basin-wide stream channel network map and GIS coverage, showing channel gradient, confinement, drainage area, estimated channel dimensions, and predicted grain size,
- shallow landslide potential map and GIS coverage,
- deep-seated landslide potential map and GIS coverage, and
- non-urban road network, including stream channel crossings, and likely culvert locations.

We will produce a final report that evaluates the application of high-resolution digital terrain data for watershed assessment and channel classification, identifying and prioritizing restoration opportunities, and guiding an adaptive management and monitoring process. These products and conclusions will be presented at a public meeting. The project team will also present a summary of final results and conclusions to CALFED.

PUBLIC FORUMS

We will hold two public meetings to present the ground surface, LIDAR-derived DTM and discuss the potential applications of the technology to watershed analysis. The meetings will provide an opportunity for stakeholders to influence how individual watershed analysis components will be performed and to provide input on the effectiveness of these products as tools for watershed-scale problem-solving by local stakeholders. Regional Board staff will also give presentations at various other agency and watershed group meetings in the Napa Valley to insure broader participation by local stakeholders.

2. Describe your qualifications and readiness to implement the proposed project. 2 PAGES

a. Describe the level of institutional structure, ability and experience to administer funds and conduct the project. Identify the fiscal agent responsible for handling the funds.

This project will be a collaborative effort between the San Francisco Bay Regional Water Quality Control Board (Regional Board), the University of Florida, the University of California at Berkeley, and Stillwater Sciences. The Regional Board will be the lead agency and fiscal agent. Michael Napolitano will be the Project Manager, with responsibility for oversight of contractors and review and approval of all work. Mr. Napolitano is an Associate Engineering Geologist who has worked at the Regional Board for over three years. He is currently responsible for coordination and oversight of the Napa River sediment total maximum daily load (TMDL) study, including administration of a $260,000 contract with the University of

California at Berkeley. Since joining the Board in November 1997, Mr. Napolitano has administered five contracts totaling over $1,400,000 and performed various duties pertaining to management and regulation of surface water quality. For the eleven years prior to coming to the Regional Board, Mr. Napolitano worked for the USDA Forest Service, National Park Service, and private consulting firms conducting geomorphic and hydrologic analyses of streams in northern and central California, often in support of watershed analysis and fisheries recovery plans. He has substantial professional experience in conducting technical studies, project management, public presentations, grant administration, stakeholder coordination, and preparation of technical reports.

b. Describe technical support available (including support needed for environmental compliance and permitting) to begin and complete the project in a timely manner.

The University of Florida (UF), University of California at Berkeley (UC Berkeley), and Stillwater Sciences will be providing technical services for the project under the direction of Mr. Napolitano. UF will be responsible for the collection and verification of LIDAR data that they will collect using airborne swath laser mapping (ASLM) technology. UF was the first academic institution in the United States to purchase an (ALSM) system and they have completed more than 25 ALSM surveys in the last four years. These projects have ranged in scale from landfills of only a few hundred acres to 280-square-mile counties. Principal investigators from UF include Dr. Ramesh L. Shrestha and Dr. William E. Carter. Dr. Shrestha is currently a professor with the Geomatics Program. He teaches courses in Geodesy, Global Positioning Systems (GPS), Geodetic Positioning, and Adjustment Computations. Dr. Carter is an adjunct professor and Chief of the NOAA Geosciences Laboratory. Dr. Carter is responsible for the maintenance and calibration of ASLM hardware; research into the application of advanced geodetic techniques, primarily the GPS system; absolute gravimetry; and ALSM. The professors are recognized leaders in ALSM research with numerous publications, national and international professional meetings, and workshops to their credit.

UC Berkeley was one of the first institutions to use laser altimetry to study hillslope and hydrologic processes. UC Berkeley and Stillwater Sciences collectively have six workstations equipped to run the latest GIS and Image Processing/Remote Sensing software packages. UC Berkeley's work on the Napa River TMDL has resulted in the creation and analysis of numerous GIS datasets for the watershed that will be used in conjunction with this project and will be invaluable in guiding some of the analyses of the digital data. Dr. William Dietrich, one of the principal investigators for this project, is Chair of the Earth and Planetary Science Departmentat UC Berkeley. He is internationally-known for his expertise in both hillslope and fluvial geomorphology and has developed DTMs that play a crucial role in watershed modeling, as well as the watershed analysis methodologies being used by Stillwater in planning efforts for the restoration of Pacific salmon in various watersheds in California and the Pacific Northwest.

Stillwater Sciences, established in 1996, is a leader in the field of watershed sciences. The firm currently employs over 35 people with expertise that includes fisheries biology, fluvial geomorphology, and GIS modeling. Stillwater employees have been involved in numerous LIDAR-related projects in northern California and Oregon, many of these in collaboration with UC Berkeley. Dr. Bruce Orr, a principal investigator for this project, has managed a variety of complex, multi-year projects that have focused on the use of watershed analysis and ecosystem management approaches to meet a variety of regulatory needs, including TMDLs, state and federal Endangered Species acts, California Forest Practice Rules, and hydropower relicensing. Dr. Orr is also well-versed in field survey techniques and identification of terrestrial plants, insects, vertebrates, and aquatic organisms.

The work described in this proposal involves airborne remote sensing and benign field sampling at a limited number of sites, therefore no environmental compliance or permitting under CEQA or NEPA will be required.

c. List any previous projects of this type you or your partners have implemented, funded either by CALFED or other programs.

UF clients include the US Army, US Geological Survey, National Aeronautics and Space Administration, Federal Aviation Administration (FAA), and National Science Foundation (NSF). Several recent UF projects have demonstrated that ALSM can effectively replace traditional methods of collecting similar data. The following is a description of some of these projects. (1) In the Everglades, where elevational differences are only a few centimeters per kilometer over large areas of surface water, the management of water requires a highly accurate elevation data. In a demonstration project, UF researchers showed that ALSM intensity data could be used to determine water surface elevations, with accuracy close to approximately three centimeters. The results meet the needs of environmental managers in charge of regulating the flow of water through the region. (2) UF researchers are collaborating with USGS scientists to use ALSM data to analyze saltwater intrusion into some coastal Florida marshes and lowland areas. Previous USGS studies in these areas have been limited by time-consuming and expensive ground surveying techniques for obtaining sub-decimeter scale topographic information for this application. Initial results of studies using ALSM data are very promising. (3) The UF is currently working with the National Geodetic Survey

(NGS) and FAA personnel to evaluate the use of ALSM for the production of airport obstruction maps. (4) The UF is working jointly with South Dakota State University on a project funded by NSF to map and study landslide areas.

UC Berkeley has been conducting landscape-modeling analyses using DTMs for more than 10 years. For the past four years, UC Berkeley has been applying these models using high-resolution LIDAR data to map basins in northern California (South Fork Eel River, Caspar Creek, Klamath River) and Oregon (Coos Bay, Roseburg, Umqua River). Examples of projects that have used high-resolution LIDAR data for watershed management applications include: (1) development of a non-linear sediment transport equation; (2) testing and validation of a shallow landslide model (SHALSTAB); (3) analysis of river longitudinal profiles by identifying the role of debris flows, knickpoints, and particle-size distribution; (4) mapping of road networks and discharge of road-related sediment into river channels; (5) detection and mapping of deep-seated landslides (funded by California Department of Forestry); (6) landscape evolution modeling combining soil models, sediment routing, channel network incision models, and tectonic forcing; and (7) dynamic modeling of shallow landsliding (CASSANDRA model, funded by NASA).

Stillwater Sciences has conducted watershed assessments for a number of large basins, including the North Umpqua River in Oregon, Jackson Demonstration State Forest, Louisiana-Pacific timberlands, and most recently the Napa River in California. Stillwater is in its third phase of a three–phase CALFED-funded project on the Merced River, and has just begun work on a CALFED-funded riparian study. Stillwater has also prepared and conducted other studies for CALFED, including evaluating benefits of upstream and delta habitat restoration projects on native fish populations, Sacramento/San Joaquin tributary assessments, and assessing the effects of water diversions on fishes in the Sacramento-San Joaquin Delta. GIS and DTMs have been used in all of these assessments. Stillwater's work has included: (1) developing numeric targets for sediment based on indicators of habitat quality for salmonid spawning and rearing; (2) a channel classification system that uses a DTM to identify channel types and their habitat constraints; (3) analyzing sources of sediment using a rapid sediment budget approach that uses a GIS/DTM analysis to stratify the watershed, coupled with intensive field investigation of sediment sources in selected subbasins; and (4) assessing and modeling stream temperature using a DTM and LANDSAT imagery to calculate riparian and topographic shading, low-flow discharge, and channel width.

3. **Provide a budget cost sheet and describe the basis for determining project costs, including comparisons with other similar projects, salary comparisons, and other listed costs. Include all costs of environmental compliance, such as CEQA and NEPA, and permits. Describe how the approach to achieving the stated goals of the project demonstrate and effective cost relative to its anticipated benefits. 2 PAGES**

Basis for Project Cost: The Regional Board is the prime contractor and fiscal administrator for this project. If this project is funded, the Regional Board will let contracts to the University of Florida (UF), the UC Berkeley, and Stillwater Sciences and, as a result, all decisions regarding project scope, budget, and direction have been made jointly. Estimates regarding project administration were developed based on the experience of personnel at the Regional Board. LIDAR data acquisition estimates were based on the experience of UF personnel who have completed over 25 surveys in the last four years. UC Berkeley and Stillwater Sciences have a longstanding partnership over numerous projects that has culminated in the development of innovative watershed assessment techniques. Cost estimates for contour generation, channel network generation, and the assessment of mass wasting potential were based upon the experience with these projects. With the exception of using LIDAR to assess unmapped roads, all of these projects used LIDAR as a tool for characterizing topography.

Comparison to Other Projects: It is the experience of the project team that watershed assessments that collect information on channel characteristics, mass wasting potential, and road-related sediment delivery cost $6 to $8 an acre. Based on these numbers, $1.8 to $2.4 million would be required to collect similarly detailed information for the entire Napa Basin. In contrast, we propose to survey the entire Napa Basin for approximately $550,000, or $2 an acre. It will take roughly four months to collect and process LIDAR data for the entire basin, whereas it would take considerably longer for field crews to cover the same area. Of course, a ground-based survey of every stream and hillslope in the basin is not possible because many private landowners restrict access to their property. In this regard, LIDAR surveys have a tremendous advantage over ground-based surveys. We will still use substantial amounts of field survey data (most of which will be paid for by matching funds) to calibrate and validate our maps and models.

Environmental Compliance: This project would not be subject to CEQA/ NEPA permitting, thus no costs are anticipated for environmental compliance.

Costs vs. Benefits: The proposed project is extremely cost-effective compared to conventional methods for conducting watershed analysis. This comparison is inaccurate however, because benefits of the proposed study are expected to vastly exceed what would have been possible in the past. In addition, the DTM created here will be readily transferable to other watershed analysis efforts in the basin (see Table 1 and letters of support), thus extending the project's potential benefits.

Matching Funds: Information on matching funds is provided on the proposal cover sheet and in the budget spreadsheet.

4. Describe the technical feasibility of the proposed project. 2 PAGES

a. Describe any similarity to previously implemented successful projects in this community or elsewhere.

Stakeholders in the Napa River watershed have a longstanding tradition of citizen involvement in watershed-scale planning, management, and restoration activities that has included: (1) the establishment of an Agricultural Preserve throughout Napa Valley in the 1960s; (2) formation of a community-based coalition to advocate and pass Measure A, the Living River Strategy, which provides flood protection via creation of wetlands and restoration of linkages between the river and its floodplain; (3) establishment of citizen watershed stewardship groups in many of its tributaries; and (4) a recent watershed task force, comprised of a representative group of stakeholders appointed by the County Board of Supervisors, that met over a two-year period ending in September 2000, to develop recommendations for local regulation and management of land-use practices involving hillside development and its effects on the natural heritage of the watershed.

None of the above projects would have been possible without the vision and foresight of the citizens and public servants of the Napa River watershed.

b. If the project proposes a new approach or new method with a high likelihood of adding new knowledge and or techniques, or with the potential to fill identified gaps in existing knowledge, describe how it will do so, and what monitoring components will provide substantiation of results.

This project will develop a novel and economical way to address watershed issues in a holistic fashion. The data will be available to private citizens, public interest groups, and local and regional agencies who can use the data to inform watershed planning efforts such as management of private lands, the ongoing TMDL study and the work of the Watershed Task Force. LIDAR data and the analyses the project partners will perform will also be useful for satisfying a number of information needs not addressed within the scope of this proposal. For example, LIDAR-derived digital canopy models have been used to characterize forest attributes, including canopy height (Nilson 1996, Naesset 1997, Magnesson and Boudewyn 1998) and biomass (Nelson et al. 1997, Means et al. 1999, Means et al. 2000). The following is a summary of the information reflected in the attached letters of support (See Table 1, as well)

- The **Land Trust of Napa County** is interested in using slope, aspect, and drainage area information provided by the DTM, in conjunction with land cover information, to delineate terrestrial habitats and vegetation communities throughout the basin. In addition, the raw LIDAR data produced during this study could be further analyzed to produce a digital canopy model that would be extremely valuable in increasing the accuracy vegetation models.

- As part of salmonid limiting factors analysis, a digital canopy model could also be used to refine stream temperature models by increasing accuracy of predictions of stream shading by topographic relief and riparian vegetation.

- The **Napa County Resource Conservation District** (RCD) is interested in using LIDAR DEMs to delineate floodplains, map channel locations, and quantify channel conveyance capacity in order to identify flood-prone areas near the town of Yountville.

- **Napa County** is preparing to hire contractors to acquire imagery for the entire Napa Basin. They are very interested in using the LIDAR DTM to orthorectify this photography.

- **The RCD** and **Napa County Planning** have expressed interest in using LIDAR data to identify problem surface erosion sources. The Regional Board is also interested in determining if LIDAR intensity measurements can be used to identify unmapped roads in forested areas and improve the accuracy of existing or road network maps.

- The **RCD** and **San Francisco Estuary Institute** (RCD-SFEI) are working with tributary watershed stewardship groups to develop detailed watershed analysis and management plans. Their project includes intensive field data collection to characterize channel condition (e.g., bank condition, channel cross-sections, dominant grain size, terraces, pool-forming mechanisms), and infer responses of streams to land uses. The high-resolution DTM and watershed analyses developed through our project will be evaluated by the RCD-SFEI as a tool for watershed stratification and extrapolation to areas where intensive surveys cannot be conducted due to funding limitations. Conversely, data collected by RCD-SFEI will be used to validate and/or calibrate the measurements and predictions of the DTM. As a result, the value and cost effectiveness of both projects should be improved.

To ensure further applicability of this information to local planning efforts, the Napa County Farm Bureau, Napa County Planning, and the Regional Water Quality Control Board will co-sponsor two public education workshops to discuss the

applications of this watershed assessment approach. These meetings will also evaluate options for making data accessible to all interested parties (e.g., printed copies of the maps, flyers, or a short report explaining potential applications and limitations, electronic data files, websites). The Regional Board will also make presentations to Farm Bureau members, local watershed stewardship groups, and public agencies.

The Regional Board also expects opportunities for community involvement in ground-truthing the laser altimetry landscape characterization.

c. Explain how the finished project will be maintained as necessary, and to what degree it may require continued funding from outside the community.

All products resulting from this study will be made publicly available, either by posting on the Internet, on an anonymous FTP site, or on workstations, with other publicly available databases, at the County Assessor's Office. As digital products the products will not require further funding for maintenance.

5. **Describe how the monitoring component of the project will help determine the effectiveness of project implementation and assist the project proponent and CALFED with adaptive management processes. 3 PAGES**

a. Identify performance measures appropriate for the stated goals and objectives of the project.

The goal of this project is to demonstrate the effectiveness of remote sensing to use well-established methods of geomorphic and habitat analysis to provide information on the physical and ecological characteristics of the Napa River Basin to guide watershed planning efforts. The project team will accomplish this by using GIS in association with LIDAR data of a finer resolution and at a larger geographic scale than has been used previously. As such, the primary performance measures appropriate to this study relate to the accuracy of the data, and a substantial portion of the proposed project (see section 5c) will involve processing and field-checking the data and analyses to ensure that it is vertically accurate to within 4 to 8 centimeters. Furthermore, to ensure that the data will facilitate local decision-making processes, the Regional Board will coordinate with stakeholders to ensure that the analyses being performed are consistent with local data gathering efforts and requirements.

The benefits of this study will be realized through its contribution to the numerous long-term projects being implemented in the Napa Basin. Although tracking change over decades is necessarily outside the scope of a focused project such as this, a general performance measure for the system as a whole would be improvement of river function toward delisting of the river basin by the US Environmental Protection Agency (USEPA) for listed impairments. The digital elevation data and GIS products resulting from the proposed project would provide a baseline with which to compare future watershed characterization efforts and a method for detecting long term changes in the watershed.

b. Describe how this project will coordinate with and support other local and regional monitoring efforts.

The watershed mapping project will be developed in close coordination with the staff of San Francisco Estuary Institute (SFEI), Napa County Resource Conservation District (RCD), Napa County Flood Control and Water Conservation District, California Department of Fish and Game, Friends of the Napa River (FONR), and US Army Corps of Engineers, all of whom are actively involved in local monitoring efforts (see Table 1 and letters of support). Coordination with the RCD and SFEI is described in detail in Section 5.e. In addition, the Regional Board has recently awarded Clean Water Act Section 319(h) and 205(j) grants to the RCD, SFEI, and FONR to monitor:

(1) runoff quality and effectiveness of best management practices for vineyards (RCD); (2) channel conditions in Dry Creek, a tributary to the Napa River (SFEI); and (3) aquatic macroinvertebrate communities at 30 stations located throughout the watershed (FONR). Water Board staff administer contracts for these projects, including review and approval of monitoring program design and data collection.

The Regional Board has also formed a local advisory committee for the TMDL study that provides a forum for TMDL project status reports and solicitation of local watershed knowledge and data. The California Coastal Conservancy and USEPA are partners in this study, and it is expected that the results will be used to identify and prioritize of restoration opportunities. All watershed mapping tools developed for this project will be accessible via work stations open to the public in the Napa County Assessor's Office.

c. Provide a description of any citizen monitoring programs that will be part of the project.

A citizens' monitoring component has not been included in this project, although products will be made available to public and public response to these products will constitute an informal role for the public in validating the accuracy of the products.

d. What monitoring protocols will be used, and are they widely accepted as standard protocols?

While this project is not an implementation program requiring monitoring in the conventional sense, this project does intend to achieve specific performance measures (see Section 5a) with respect to the quality of the data collected. To this end, two monitoring protocol categories are proposed. The first set of protocols, "Quality Control/Quality Assurance," is designed to test the validity of the LIDAR-derived DTM. The second set of protocols, "Model Validation," will test the accuracy of data derived from the DTM. In both cases, field data collected from the ground-based surveys will be used to test LIDAR-based characterizations of the landscape. These field data will also be used to test assumptions embedded in the channel classification system and desktop watershed approach. Specifically, field surveys will be designed to validate the assumed habitat linkages (and species associations) with the DTM-generated stream types. In addition, the ground-based survey methods being proposed here are typical of standard watershed assessments and will therefore be extremely valuable in the future for providing a geographically referenced snapshot of conditions in the basin that can be compared to the results of future surveys

Quality Control/Quality Assurance: The objective of the Quality Control/Quality Assurance monitoring program is to ensure that the DTM accurately represents the topography of the Napa Basin. An Inertial Measurement Unit and a kinematic Global Positioning System (GPS) will be used to produce latitude, longitude, vertical elevation, and return signal intensity for each captured echo. To correct systematic GPS error, University of Florida (UF) personnel will operate at least two GPS ground stations during all data collection sessions, and station coordinates will be verified by connection to the National Geodetic Survey Continuously Operating Reference Station (CORS) network. To reconcile any possible systematic errors, the ALSM data will be collected with up to 30% overlap of adjacent swaths. A separate DTM is made for each swath, fixing the grid points at identical values, so that gridded data can be compared to adjacent swaths to determine if any systematic height differences exist between swaths. If differences exceed 10 cm, the calibration parameters will be evaluated and adjusted. The removal of ground clutter, and the production of a bare earth DTM and contour maps would be performed at the UF laboratory, using commercially and UF-developed software, following procedures developed in previous projects. Projects distributed throughout the eastern United States, from Florida to South Dakota, consistently produce root mean square error (RMSE) agreement of 4 to 8 centimeters between ALSM points and ground surveying on hard surfaces.

Monitoring for Model Validation: A stratified approach will be used for the following validation studies. This approach will consist of testing products in relation to a set of sites within the Napa Basin that represent the range of topographic and land-use conditions found in the basin. Appropriate sites will be intensively studied to test the performance of models. This approach will allow testing of the products under the most technically demanding conditions as well as more routine conditions. All field data will be geographically referenced using high resolution GPS equipment.

Digital Terrain Model: As a final test for systematic error, longitudinal profiles will be surveyed across selected areas of the basin and the survey data will be compared to the cross-section of the DTM that corresponds to the long profile location. The heights from the two data sources will then be compared. Previous studies indicate that we can expect the RMSE of the differences to be in the range of 4 to 8 centimeters.

Stream Channel Network: Several field-based efforts will be implemented to validate the results of the stream channel network modeling. In combination with already-collected field data from the Regional Board's Napa TMDL Phase I study, the project team will coordinate with SFEI's 205(j) study and the Regional Board's Phase II studies to collect data on the stream network. Data to be collected includes channel locations (particularly small channels and low-order channel heads), selected longitudinal profiles, and cross sections in higher order channels to test the resolving power of the DTM with respect to channel dimensions and the performance of our channel confinement algorithms. Data on particle size, channel morphology, and habitat parameters will also be collected and will be compared to and used to calibrate model predictions.

Mass Wasting Potential: A limited field investigation will be combined with extensive aerial photographic analysis, and analysis of California Department of Mines and Geology maps, to document the actual site of landslides in the field in order to check model performance. These landslides will be geographically registered and compared to landslides predicted by the SHALSTAB model.

Road Network: The effectiveness of the LIDAR data to detect unmapped roads in the Napa Basin will be tested by checking the DTM signature of known roads of different types (e.g., paved, dirt) in different terrains. While roads are generally resolved by DTM techniques due to their topographic signature, the LIDAR return intensity data that will be collected in this study will offer the opportunity to resolve roads based on their differential surface composition compared to surrounding areas. To this end, the project team will select areas from the DTM with distinctive intensity signatures and field check actual conditions to assess true ground surface composition.

e. Describe how the type and manner of data collection and analysis will be useful for informing local decision making.

Mapping: No maps are currently available for the Napa River watershed that accurately delineate the entire channel network (this is true for most other basins as well). Fundamental to protection of stream and riparian functions, and balancing of the costs and benefits of management decisions, is the knowledge of where streams are located, how biological and physical attributes vary longitudinally from headwaters to mouth, and prediction of how streams and riparian corridors may respond to management actions. The project team will produce a high-resolution (5-m) DTM that will be used for numerous analyses related to network delineation, characterization, and landscape-scale modeling (see Section 1).

Geomorphic Data: Channel attribute data will be applied to important land-use issues currently facing local government and watershed stewardship groups, to evaluate: (1) channel response to disturbance; (2) sediment transport (through modeling techniques); (3) ecological functions, including habitat quantity and quality for sensitive species, and (4) predicting distributions of native fishes, amphibians, and other aquatic and riparian species.

High-resolution digital topographic data may also be used[2] in Phase II of the Napa River sediment TMDL study to: (1) delineate important sources of sediment supply to channels, such as roads and colluvial hollows (thick soil deposits on un-channeled hillslopes); (2) measure vegetation height, canopy structure, and estimated biomass (to determine stream shading for temperature modeling and estimate potential recruitment of large wood to channels), and evaluate habitat quantity and quality for riparian and aquatic species; and (3) use in combination with experimental data and land-use GIS coverages to model sediment production at the basin scale.

Land Use Data: There are numerous private sector applications for the data that will be produced in this project, particularly for land-use management planning. In general, the proposed project is essential to local decision makers for planning and managing both local impacts as well as for considering cumulative effects of land-uses in the watershed. Uses include planning by individuals in the vintner, developer, and timber harvest communities. Informed decision-making relies on consideration of both regional and site-specific land-uses and the local and downstream impacts of those activities. The proposed project will encompass the entire Napa River watershed and will characterize the essential landscape components that will inform local and cumulative effects. There are a number of local efforts at watershed scale land use analysis ongoing in the Napa region.

The **Napa River Watershed Task Force**, appointed by the Napa County Board of Supervisors, recently developed consensus recommendations in September 2000, regarding managing potential impacts of hillside development on the environmental health of the watershed. As a result, several strategies are being considered, including revision of its Hillside Conservation Ordinance to establish setbacks for new agricultural and development projects, and measures to control changes in peak runoffand protect rare terrestrial habitats and species, including oak woodland communities. One of the more challenging issues, not resolved by the Task Force, was determining stream setback size for the replanting of existing vineyards. Channel and riparian attribute data developed by this project would be tremendously useful to stakeholders in this planning process for evaluating the environmental benefits and economic costs of stream setbacks, and for identification of hillside areas that may be particularly sensitive to increases in peak runoff and erosion.

The Watershed Task Force also recommended establishment of a Land Conservancy and a Watershed Information Center to promote conservation of native biodiversity. The watershed mapping and analyses proposed here would be used as topographic and channel base-maps against which all other watershed data could be referenced to as part of the process of identifying priority sites for conservation easements and restoration projects.

Similarly, the **Land Trust of Napa County** is interested in precisely delineating terrestrial habitats and vegetation communities throughout the watershed. High-resolution digital topographic data will greatly reduce the cost of digital ortho-photography that could be used to map vegetation communities and identify key potential refugia for rare or threatened species.

Napa County Resource Conservation District and **San Francisco Estuary Institute** are working with tributary watershed stewardship groups to develop detailed watershed analysis and management plans. Plans for two such tributaries to the Napa River, Sulfur and Carneros creeks, are the subject of a proposal now being submitted to the CALFED Watershed Program.

Other potential future applications of the DTM include delineation of barriers to aquatic habitat connectivity, a digital canopy model, solar irradiance and stream temperature modeling, and orthorectification of aerial photographs. In view of the fact that many terrestrial ecosystems are strongly controlled by topographic factors such as slope, aspect, and drainage area, the

[2] Pending findings in Phase I of the TMDL study, an evaluation of factors limiting populations of rare and threatened native stream-riparian species, and provide amount of funding for Phase II of the study.

DTM could be used to conduct more complex analyses of watershed resources and functions, such as detailed vegetation typing, terrestrial wildlife habitat typing, and large woody debris recruitment to streams. (See Section 4b)

6. **If this project is to develop specific watershed conservation, maintenance or restoration actions, describe the scientific basis for the action(s) described in the proposal. Include the following: 2 PAGES**

[*The Water Board acknowledges that this project does not constitute an implementation action, however question #6 is being answered in full because the information provided by this project would be relied upon by other parties to develop implementation priorities and thus would influence the scientific those projects.*]

a. Any assessment of watershed conditions that has already been developed by you or others.

The *Napa River Watershed Background Information Report* was completed in 1992 by the staff of the San Francisco Bay Water Quality Control Board to facilitate watershed planning. The report summarizes data available at that time to characterize natural resource conditions, key concerns and threats to material and biotic resources, and recommendations for watershed protection and rehabilitation. Recommended priorities for land-use management in the watershed were further elaborated in the *Napa River Watershed Owners Manual* (Napa County Resource Conservation District 1994). Studies completed to evaluate flood management project alternatives in the late 1980s and early 1990s by the US Army Corps of Engineers (USACE), including the *Napa River Sediment Engineering Study* (Water Engineering and Technology 1990), provide a general characterization of mainstem channel dynamics and sediment transport, as well as a review of data collected in the watershed on sediment yields and bank erosion severity.

Reports by the California Department of Fish and Game, including a petition to the State Water Quality Control Board (Anderson, 1972) cite key concerns associated with the rapid decline of steelhead runs, including intensive surface water diversion, and increases in stream temperature, nutrient, and sediment loads associated with urban and agricultural development. In consideration of the status of steelhead and other sensitive species, the Regional Board has listed the Napa River and its tributaries as impaired by excess sediment supply. As such, the Regional Board is required to develop a TMDL study to determine pollution sources and develop a plan to restore the health of the watershed.

The Napa River sediment TMDL, begun in June 2000, is a two-phased study. The first phase, expected to be completed in March 2002, will describe the current biotic and geomorphic state of the Napa River system, while the second phase is designed to develop an understanding of watershed processes and land-use practices and their causal linkages to the river ecosystem. Specifically, Phase I will be a rapid, field-based assessment of current in-stream channel conditions that is designed to identify key factors limiting the production of steelhead and chinook salmon in the mainstem Napa River and selected tributaries, provide a review of historical and current watershed conditions. Phase II is an integrated watershed analysis designed to establish causal linkages between geomorphic and hydrologic processes and channel conditions. In Phase II, we will develop and use an erosion control model designed to evaluate the effects of different land-use scenarios on physical habitat conditions in stream channels. The Phase II watershed assessment will then identify linkages between the physical environment, including key sediment sources, and populations of aquatic and riparian species and other beneficial uses. Phases I and II will employ the use of reference state baseline conditions to help evaluate current conditions and trends and potential future conditions and trends.

b. Previous assessments used to establish your project goals and objectives, or to inform the basic assumptions of your proposal.

Watershed analysis and regional assessment projects conducted by Stillwater Sciences in northern California and Oregon for timber companies, hydroelectric utilities, and state and federal agencies have all applied the desktop watershed approach (Montgomery et al. 1998) to incorporate DTM data into a GIS and quantify resource states based on known linkages between the physical environment and ecosystem quality. Stillwater Sciences' experiences from these projects have confirmed the efficacy of exploring ecosystem issues at the watershed scale using digital terrain data embedded within a GIS. These experiences have also served to point out the shortcomings of existing digital elevation data (10-meter and 30-meter 7.5 USGS DEMs) in accurately representing landscape features and functions relevant to biological systems and native species.

Our work in the North Umpqua basin in Oregon involved embedding a population dynamics model within a GIS-based biophysical model to explore and quantify numbers of salmonids at different life stages in different parts of the watershed. We also developed GIS-based tools for conducting temperature and sediment TMDLs for the South Fork Eel basin in northern California. A GIS-based stream temperature model was developed to assess reach-based temperature changes in relation to canopy height. A GIS-based road sediment production model was developed for the sediment TMDL for the same basin.

c. A description of the scientific assumptions used to develop the project goals, objectives and proposed actions, and the degree to which these assumptions are widely accepted (both in the science community as a whole, and in the watershed community).

It is widely accepted in the scientific community that geomorphic landscape patterns are influenced by a limited number of predictable physical processes. There is an unambiguous hierarchical structure and organization in the integration of fluvial systems and adjacent hillslopes. Water and sediment delivered from the hillslopes collects in the channels and is systematically moved downstream. The strongly hierarchical nature of the system provides the conceptual basis for classifying the stream channel network. Interactions between erosional and depositional processes form a hierarchical network of channels, ranging from steep channels with small drainages, where erosion (sediment production) and colluvial transport processes dominate, to progressively less steep channels, with increasing drainage areas, characterized by alluvial sediment transport processes, and ultimately to very low-gradient channels dominated by sediment deposition. These hillslope erosion and channel-forming processes vary predictably with slope and less so with drainage area, and are tied to the formation of ecologically important channel attributes such as grain size, structural complexity, channel morphology, width, disturbance frequency, embeddedness, etc. Such a process-based classification system (e.g., Montgomery and Buffington 1997, 1998) permits explicit hypothesis testing of linkages between physical channel attributes (e.g., gradient, confinement, bankfull width, depth) and biological potential. The hierarchical organization of the system permits field-based, point measurement of important channel properties (e.g., channel width, depth, LWD loading) that can be extrapolated to the entire GIS-based stream channel network. Subsequent field surveys are used to verify the accuracy of these assumptions, and to explore relationships between the stream types categorized in the classification system and their habitat characteristics. This type of modeling can play a key role in the adaptive management process because it allows stakeholders to explore the impacts of various management alternatives without entailing the expense and risk of large-scale experiments. A model of this type allows efficient identification of key areas of interest in the landscape, thus making efficient allocation of field effort for characterization prior to extrapolation.

d. A discussion of how the proposed actions are (are not) consistent with the scientific assumptions and previous assessments completed in the watershed.

The proposed project is consistent with the scientific assumptions proposed herein. We propose to build a high-resolution digital database characterizing the landscape properties essential for understanding the integration of physical and biological systems within the watershed. What distinguishes this effort from previous assessments is that we propose to generate high-resolution baseline digital elevation data that accurately capture the full heterogeneity of the landscape's topography at the resolution necessary to explore linkages between these physical and biological systems. Previous studies conducted by UC Berkeley and Stillwater Sciences, both in the Napa basin and elsewhere have had to rely on the then 'best-available' digital elevation data (typically 10-meter USGS DTMs), which are readily acknowledge to poorly represent (or misrepresent) the reach-scale complexities necessary for understanding ecosystem functioning. Furthermore, coarser resolution digital data routinely fail to capture the full spatial extent of the channel network and routinely introduce spurious stream segments (see extracted channel comparison, Figure 2). These deficiencies have important implications for local assessment of ecosystem potential and for exploring cumulative effects.

This project is fully consistent with ongoing and previous efforts at watershed assessment within the Napa Basin. While previous work has been constrained by technical difficulties in accurately characterizing entire river basins, LIDAR represents an opportunity for a unified approach to landscape-scale hypothesis formation, testing, and data interpretation that was not previously possible, but that is widely accepted as a critical component of watershed analysis.

e. A description of what baseline knowledge was used to support the management actions described in the proposal, or the likelihood that the management actions will generate more robust baseline knowledge.

The first step in the management process is the collection of appropriate data to guide decision-making. Rather than being a management action *per se*, this project acts as this first step. The Napa basin is an intensively managed system with a wide variety of stakeholders. The consensus-building and decision-making process relies on an accurate information base to proceed successfully. As many of the management challenges in the Napa system relate to topographic and geomorphic issues, this project would provide a key component of such an information base. (See Table 1 and letters of support)

7. **How will the proposal address multiple CALFED objectives (see Section I) in an integrated fashion, with emphasis on water supply reliability, water quality, ecosystem quality, and levee stability objectives CALFED has established for Stage 1 of the program? 1 PAGE**

The proposed project will address all primary CALFED objectives by demonstrating a powerful and cost-effective tool for analyzing physical and biological functions of watersheds and predicting responses to a wide variety of potential land and

water management strategies. One of the driving reasons for conducting this study is the need for a new approach to assess e**cosystem quality** in a system such as the Napa Basin, where the cost of landscape-scale assessment would be prohibitive and where access to sampling sites is difficult. This study will assess ecosystem quality as it relates to aquatic habitat. **Water supply reliability** for human consumption is governed not only by the physical processes conveying water through a system, but also by constraints imposed on withdrawals by the habitat needs of aquatic organisms. The modeling approach proposed here will lead to a better understanding of aquatic habitat characteristics in the system and how these habitat characteristics might respond to flow variability. While not included in this study, the information gathered could facilitate efforts to reconcile mismatches between water supply and the needs of aquatic species. From the watershed analysis perspective, **water quality** is subject to degradation due to cumulative effects of non-point source pollutants, such as sediment. This project will address the issue of cumulative effects by exploring the use of a potentially powerful tool through which processes leading to cumulative effects can be assessed. The **levee system integrity** of the Napa system will not be directly addressed by the proposed study, but will be addressed indirectly insofar as levees represent features with clear topographic expression and will therefore be represented in great detail by the DTM that would be produced. Flood control and emergency management planners working for Napa County and hydrologists with the RCD have stated that they will use this data (see Table 1 and letters of support).

Explain how the proposal will help define and illustrate relationships between watershed processes (including human elements), watershed management, and the primary goals and objectives of CALFED (see Section I).

The "desktop watershed" approach proposed in this watershed mapping partnership would illustrate the function of the Napa watershed as whole system. The role of human elements and the impacts of management options will be demonstrated through the use of spatially explicit models. Fine sediment reduction measures, changes in the flow regime, and riparian tree height and canopy structure can be simulated with such models. The relative costs and benefits of these and other management actions can then be evaluated in relation to their predicted effects on populations of native species of interest, so that resource benefits can be maximized in an integrated fashion in relation to management costs. By demonstrating the interconnected nature of all components of the Napa River system—something that can only be accomplished using a DTM—this project would define and illustrate the goals and objectives of CALFED and relate them to specific management alternatives.

Identify a lead agency for environmental compliance, such as CEQA or NEPA. Describe the program's strategy and timetable on environmental compliance.

All work proposed in this project involves either remote sensing or benign field data collection. As such, it is not subject to CEQA or NEPA permit requirements.

8. **Describe any other important aspects of your program that you could not address in the above items, and that you feel are critical to fully describing your project. 2 PAGES**

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CALFED WATERSHED PROGRAM BUDGET AND PROJECT SUMMARY II

	Task Description	Completion date	Direct Labor (Hours)	Direct Salary and Benefits	Service Contract	Match Funds	CALFED Funds	Total
Task 1:	**Administration**	**Dec-02**	**590**	**34,047**	**0**	**$34,047**	**$0**	**$34,047**
Task 2:	**LIDAR data acquisition/processing**	**Jan-01**	**0**	**0**	**274,100**	**$74,000**	**$200,100**	**$274,100**
Task 2a:	Moblize ALSM equipment and set up base in California	Oct-01			23,000	$7,500	$15,500	$23,000
Task 2b:	Collect ALSM data and ground truth	Oct-01			134,600	$36,500	$98,100	$134,600
Task 2c:	Process ALSM point data and deliver data products	Jan-02			116,500	$30,000	$86,500	$116,500
Task 3:	**Generate elevation contours**	**Feb-01**	**0**	**0**	**3,200**	**$1,000**	**$2,200**	**$3,200**
Task 3a:	Generate elevation contours	Feb-02			3,200	$1,000	$2,200	$3,200
Task 4:	**Generate stream channel network**	**Sep-01**	**0**	**0**	**146,400**	**$81,500**	**$64,900**	**$146,400**
Task 4a:	Collect baseline field data	Oct-01			50,000	$42,500	$7,500	$50,000
Task 4b:	Prepare DTMs for hydrologic modeling	Mar-02			31,200	$10,000	$21,200	$31,200
Task4c:	Generate and edit channel network	Apr-02			12,800	$3,000	$9,800	$12,800
Task 4d:	Develop attributes for digital stream channel arcs	Jul-02			18,400	$4,000	$14,400	$18,400
Task4e:	Develop channel confinement algorithms	Jul-02			8,000	$2,000	$6,000	$8,000
Task 4f:	Field verify digital channel attribute predictions	Sep-02			26,000	$20,000	$6,000	$26,000
Task 5:	**Evaluate mass wasting potential**	**Jul-01**	**0**	**0**	**30,600**	**$19,500**	**$11,100**	**$30,600**
Task 5a:	Generate slope instability grids using shallow landslide model	Jul-02			3,200	$1,500	$1,700	$3,200
Task5b:	Generate slope instability grids using deep seated landslide model	Jul-02			2,400	$500	$1,900	$2,400
Task 5c	Field validation of model and maps	Aug-01			25,000	$17,500	$7,500	$25,000
Task 6:	**Generate road network**	**Jul-01**	**0**	**0**	**8,000**	**$11,000**	**$7,000**	**$18,000**
Task 6a:	Generate Road Network	Jul-02			8,000	$3,000	$5,000	$8,000
Task 6b:	Field validation	2-Aug			10,000	$8,000	$2,000	$10,000
Task 7:	**Initial Public Meeting**	**1-Sep**	**70**	**4039**	**5000**	**$4,039**	**$5,000**	**$9,039**
Task7a:	Meeting preparation	Sep-01	30	1731	4,000	$1,731	$4,000	$5,731
Task 7b:	Meeting attendance	Sep-01	40	2308	1,000	$2,308	$1,000	$3,308
Task 8:	**Final Report**	**Dec-01**	**200**	**9231**	**26500**	**$9,231**	**$28,000**	**$37,231**
Task 8a:	Data analysis and synthesis	Oct-02	20	577	14,000	$577	$14,000	$14,577
Task 8b:	Preparation for final public meeting	Dec-02	20	577	6,000	$577	$6,000	$6,577
Task 8c:	Attend final public meeting to present results	Dec-02	20	577	1,000	$577	$4,500	$5,077
Task 8d:	Draft Final Report	Dec-02	80	4,615	2,000	$4,615	$1,000	$5,615
Task 8e:	Final Report	Dec-02	40	2,308	2,000	$2,308	$1,000	$3,308
Task 8f:	Present results to CALFED	Dec-02	20	577	1,500	$577	$1,500	$2,077
TOTAL			**860**	**47317**	**493,800**	**$234,317**	**318300**	**552617**